



# **FEE TRANSMITTAL** **FY 2001**

Complete if Known

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Filing Date	Herewith
First Named Inventor	CABANA
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## METHOD OF PAYMENT

1. ☒ **Payment Enclosed:**  
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## FEE CALCULATION

## 1. FILING FEE

## Large Entity

Fee (\$)	Fee Description	Fee Paid
710	Utility filing fee	710.00
320	Design filing fee	
150	Provisional filing fee	

	Number Filed	Number Extra	Rate	Amount
Total Claims	32	- 20 = 12	x \$ 18.00 =	216.00
Independent Claims	11	- 3 = 8	x \$ 80.00 =	640.00

☐ Multiple Dependent Claim(s), if any \$270.00 = 0.00

TOTAL: 1,566.00

SMALL ENTITY DISCOUNT: 0.00

SUBTOTAL (1) (\$) 1,566.00

## 2. AMENDMENT CLAIM FEES

Claims Remaining After Amend.	Highest No. Previously Paid For	Present Extra	Rate	Fee Paid
Total	-	=	x \$ 18.00 =	
Indep.	-	=	x \$ 80.00 =	
<input type="checkbox"/> First Presentation of Multiple Dep. Claim			+ \$270.00 =	

TOTAL: (\$0.00)

SMALL ENTITY DISCOUNT: (\$)

SUBTOTAL (2) (\$0.00)

## FEE CALCULATION (continued)

## 3. ADDITIONAL FEES

Large Entity Fee (\$)	Small Entity Fee (\$)	Fee Description	Fee Paid
130	65	Surcharge - late filing fee or oath	
50	25	Surcharge - late provisional filing fee or cover sheet	
130	130	Non-English specification	
2,520	2,520	For filing a request for reexamination	
110	55	Extension for reply within first month	
390	195	Extension for reply within second month	
890	445	Extension for reply within third month	
1,390	695	Extension for reply within fourth month	
1,890	945	Extension for reply within fifth month	
310	155	Notice of Appeal	
310	155	Filing a brief in support of an appeal	
270	135	Request for oral hearing	
130	130	Petitions to the Commissioner	
50	50	Petitions related to provisional applications	
180	180	Submission of Information Disclosure Statement (37 CFR 1.97(c))	
180	180	Submission of Information Disclosure Statement (37 CFR 1.97(d))	
710	355	Filing a submission after final rejection (37 CFR 1.129(a))	
710	355	For each additional invention to be examined (37 CFR 1.129(b))	

Other fee (Specify)

Other fee (Specify)

SUBTOTAL (3) (\$) 0.00

SUBTOTAL (1) 1,566.00

SUBTOTAL (2) 0.00

SUBTOTAL (3) 0.00

TOTAL (\$) 1,566.00

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## CORRESPONDENCE INFORMATION

## APPLICATION INFORMATION

## REPRESENTATIVE INFORMATION

## CONTINUITY INFORMATION

- 2 -

### PRIOR FOREIGN APPLICATIONS

## Foreign Application One ::

Filing Date ::

Country ::

Priority Claimed ::

1070878-1

Figure 1 consists of 12 sub-graphs labeled (a) through (l), each showing the growth of *E. coli* O157:H7 in ground beef under different conditions. The y-axis for all graphs is  $\log_{10}$  CFU/g, ranging from 0 to 10. The x-axis is time in hours, ranging from 0 to 24. The graphs show various growth curves, including control, heat treatment, and different chemical treatments.

- (a) Control: Shows a steady increase in bacterial count from approximately  $10^1$  to  $10^8$  CFU/g over 24 hours.
- (b) Heat treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (c) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (d) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (e) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (f) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (g) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (h) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (i) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (j) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (k) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.
- (l) Chemical treatment: Shows a decrease in bacterial count from approximately  $10^1$  to  $10^0$  CFU/g over 24 hours.

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**Method and Apparatus for Optimized Image Processing**

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Field of the Invention

The present invention relates generally to digital printing methods and apparatus and, more specifically, to methods and apparatus for improving the compilation  
5 of image data and optimizing the accuracy of rendered images.

Background of the Invention

Various methods and technologies exist for encoding documents digitally and transferring the digital representations to output devices. At the encoding stage, these range from hobbyist scanners and associated software to elaborate prepress systems.  
10 These systems have replaced traditional “cut and paste” approaches to layout, which required painstaking manual arrangement of the various document components—text, graphic patterns and photographic images—onto a white board for subsequent reproduction. Instead, designers can now manipulate all of these components at once using computers.

15       Output of the digitally encoded documents can take numerous forms, ranging from laser printing to digital exposure of photographic films to transfer of the image to lithographic plates for subsequent mass-quantity printing. In the latter case, the image to be printed is present on a plate or mat as a pattern of ink-accepting (oleophilic) and ink-repellent (oleophobic) surface areas. In a dry printing system, the plate is simply inked  
20 and the image transferred onto a recording material; the plate first makes contact with a compliant intermediate surface called a blanket cylinder which, in turn, applies the image to the paper or other recording medium. In a wet lithographic system, the non-image areas are hydrophilic, and the necessary ink-repellency is provided by an initial application of a dampening (or “fountain”) solution to the plate prior to inking. The ink-abhesive

fountain solution prevents ink from adhering to the non-image areas, but does not affect the oleophilic character of the image areas.

Lithographic plates can be fabricated in various ways, ranging, once again, from traditional manual techniques involving photoexposure and chemical development to automated procedures involving computer control. Computer-to-plate systems can utilize pulses of electromagnetic radiation, produced by one or more laser or non-laser sources, to create physical or chemical changes at selected points of sensitized plate blanks (which, depending on the system, may be used immediately or following conventional photodevelopment); ink-jet equipment used to selectively deposit ink-repellent or ink-accepting spots on plate blanks; or spark-discharge equipment, in which an electrode in contact with or spaced close to a plate blank produces electrical sparks to alter the characteristics of certain areas on a printing surface, thereby creating "dots" which collectively form a desired image. As used herein, the term "imaging device" includes radiation sources (e.g., lasers), ink-jet sources, electrodes and other known means of producing image spots on blank printing plates, and the term "discharge" means the image-forming emissions produced by these devices. The term "image" refers to a lithographic representation of the final document to be reproduced. The term "plate" refers to any type of printing member or surface capable of recording an image defined by regions exhibiting differential affinities for ink and/or fountain solution; suitable configurations include the traditional planar or curved lithographic plates that are mounted on the plate cylinder of a printing press, but can also include seamless cylinders (e.g., the roll surface of a plate cylinder), an endless belt, or other arrangement.

A second approach to laser imaging involves the use of transfer materials. See, e.g., U.S. Patent Nos. 3,945,318; 3,962,513; 3,964,389; 4,245,003; 4,395,946; 4,588,674; and 4,711,834. With these systems, a polymer sheet transparent to the radiation emitted by the laser is coated with a transferable material. During operation the transfer side of this construction is brought into contact with an acceptor sheet, and the transfer material is selectively irradiated through the transparent layer. Typically, the

transfer material exhibits a high degree of absorbence for imaging laser radiation, and  
ablates--that is, virtually explodes into a cloud of gas and charred debris--in response to a  
laser pulse. This action, which may be further enhanced by self-oxidation (as in the case,  
for example, of nitrocellulose materials), ensures complete removal of the transfer  
5 material from its carrier. Material that survives ablation adheres to the acceptor sheet.

Alternatively, instead of laser activation, transfer of the thermal material can be  
accomplished through direct contact. U.S. Patent No. 4,846,065, for example, describes  
the use of a digitally controlled pressing head to transfer oleophilic material to an image  
carrier.

10 To create a printing plate, the transfer and acceptor materials are chosen to  
exhibit different affinities for fountain solution and/or ink, so that removal of the  
transparent layer together with unirradiated transfer material leaves a suitably imaged,  
finished plate.

Another important application of transfer materials is proofing. Graphic-arts  
15 practitioners use color proofing sheets (or simply "color proofs") to correct separation  
images prior to producing final separation plates, as well as to evaluate the color quality  
that will be obtained during the printing process. In typical printing processes, multicolor  
images cannot be printed directly using a single printing plate. Rather, composite color  
images are first decomposed into a set of constituent color components, or "separations",  
20 each of which serve as the basis for an individual plate. The colors into which the  
multicolor image is decomposed depends on the particular "color model" chosen by the  
practitioner. The most common color model is based on cyan, magenta, yellow and black  
constituents, and is referred to as the "CMYK" color model. If the separation is  
performed properly, subtractive combination of the individual separations produces the  
25 original composite image. A color proof represents, and permits the practitioner to view,  
the final image as it will appear when printed.



A color proof may be produced by irradiative transfer of a coloring agent, corresponding to one of the separation colors, onto a transparent acceptor sheet according to the distribution of that color in the final image. Transfer sheets corresponding to each color of the model can be applied to a single acceptor sheet and sequentially imaged, producing a single-sheet proof. Alternatively, a set of color proofs each corresponding to one of the colors may be superposed on each other in registration, thereby revealing the final image.

Mechanically, laser-based imaging systems can take a variety of forms. Laser output may be provided directly to the surface of a substrate via lenses or other beam-guiding components, or transmitted to the surface from a remotely sited laser using a fiber-optic cable. A controller and associated positioning hardware maintains the beam output at a precise orientation with respect to the substrate surface, scans the output over the surface, and activates the laser at positions adjacent selected points or areas of the substrate. The controller responds to incoming image signals corresponding to the original document or picture being copied onto the substrate to produce a precise negative or positive image of that original. The image signals are stored as a bitmap data file or other suitable image format on a data storage device. Such files may be generated by a raster image processor (RIP) or other suitable means. For example, a RIP can accept input data in page-description language, which defines all of the features required to be transferred onto the substrate, or as a combination of page-description language and one or more image data files. The bitmaps are constructed to define the hue of the color as well as screen frequencies and angles.

The imaging apparatus can be configured as a flatbed recorder or as a drum recorder, with the substrate mounted to the interior or exterior cylindrical surface of the drum. In the case of lithographic printing, the exterior drum design is more appropriate to use in situ, on a lithographic press, in which case the print cylinder itself constitutes the drum component of the recorder or plotter.

In the drum configuration, the requisite relative motion between the laser beam and the substrate is achieved by rotating the drum (and the substrate secured thereon) about its axis and moving the beam parallel to the rotation axis, thereby scanning the substrate circumferentially so the image “grows” in the axial direction. Alternatively, the beam can move parallel to the drum axis and, after each pass across the substrate, increment angularly so that the image on the substrate “grows” circumferentially. In both cases, after a complete scan by the beam, an image corresponding (positively or negatively) to the original document or picture will have been applied to the surface of the substrate.

Multiple imaging devices may be used to produce several lines of image spots simultaneously, with a corresponding increase in imaging speed. Regardless of the number of imaging devices used, their operation must be precisely controlled so that the discharges occur at the appropriate times to reach the intended dot locations on the printing surface. Each discharge source must be aligned with the substrate along longitudinal and lateral dimensions (corresponding to circumferential and axial directions in the case of drum imaging) at all points during a scan of the all candidate image points on the substrate, and, in the case of laser-based imaging, the beam must remain focused on the substrate for maximum energy-transfer efficiency.

The overall efficiency of the imaging apparatus is an important operational criterion. Operational bottlenecks degrade the performance of the apparatus resulting in, for example, a slowdown in the production of the lithographic plates. In laser-based imaging systems, the bottlenecks can preclude operation at commercially realistic imaging rates. One typical bottleneck relates to the acquisition of image data stored, as described above, as a bitmap file on a data storage device. The imposition (i.e., combination) of multiple bitmaps during the imaging output process compounds this problem.

Another bottleneck is encountered when the imaging apparatus uses a “combed array” of laser imaging devices. In this configuration, multiple laser imaging

devices are distributed across a dimension of the substrate. This distribution can be as simple as a linear array where each imaging device is equidistant from the next.

Alternatively, groups of imaging devices may be clustered into one or more “packs”

where the spacing between the devices within a pack differs from the spacing between

5 adjacent packs. Irrespective of the configuration, each imaging device, depending on its physical location within the array, is responsible for imaging a different portion of the

overall image. The bottleneck occurs because the imaging devices operate

simultaneously and the data required by each imaging device typically comes from

different positions within the bitmap file. Consequently, multiple mass storage

10 transactions (i.e., reads and seeks) are performed on the file to acquire the needed data from several non-contiguous locations within the file.

One way to optimize data flow to the imaging devices has been to include

buffer memory in the imaging apparatus. The buffer memory may, for example, be

configured as one or more buffer pairs; the imaging devices read data from only one of

15 each pair (e.g., the “A Buffer”). While the imaging devices are reading the data in “A

Buffer”, the other member of the pair (e.g., the “B Buffer”) is receiving data from the

data storage device. When the imaging devices exhaust the data in the “A Buffer”, they

begin to read data from the “B Buffer”. Simultaneously, the “A Buffer” once again

begins to receive data from the data storage device. The roles of the “A Buffer” and “B

20 Buffer” reverse again when the imaging devices exhaust the data in the “B Buffer”. This process continues until the entire image is processed.

The role reversal of the “A” and “B” buffers improves data throughput and efficiency, but it does not address the delay time inherent in accessing image data from a

number of different files or accessing image data from a number of files using a combed

25 array of imaging devices. Retrieving these files, which are typically stored on mass

storage media, entails additional overhead associated with accessing the media. This

overhead degrades the efficiency of the imaging apparatus. Furthermore, as the number

of files or retrieval requests increase, the total overhead grows, further slowing the imaging apparatus.

During the operation of imaging apparatus, it is also important to maintain image “registration” (i.e., alignment) along all relevant dimensions. Failure to do so results in imaging inaccuracies or undesirable artifacts, or both, that detract from the final image appearance. The consequences can be particularly acute in planographic printing contexts, since typical print jobs require sequential application of ink from several plates resulting in a cumulative aggregation of the imperfections associated with each plate. Laser imaging imposes especially demanding requirements, since adjustments along each of the relevant dimensions can result in introduction of distortions along the other dimensions.

Manufacturing tolerances also produce variations in the dimensions (e.g., circumferences) of the printing plate cylinders. Thus, there is a likelihood that in a four-color imaging system which incorporates four separate cylinders (each which is paired with its own set of imaging devices) the four circumferences will not be the same. Accordingly, adjustments must be made to the operation of the imaging devices in order to produce four printing plates whose images are the same size in the circumferential direction.

From the foregoing, it is apparent that there is still a need for a way to increase the efficiency of imaging apparatus while simultaneously optimizing image accuracy.

### Summary of the Invention

The present invention facilitates increased throughput between raw image data files and the imaging devices that will ultimately apply a complete image onto recording medium. This increases the speed and efficiency of the overall imaging apparatus.

Furthermore, the invention allows for the adjustment of image dimensions, providing a dynamic “stretch” and “shrink” capability. This permits correction of registration errors

caused by, for example, variations in cylinder diameters and speed, and also affords general control over image size. The invention represents a simple and effective way to optimize the operation of imaging equipment.

In one embodiment, a final image is compiled from two or more raw image data files, each file containing one or more portions of the final image. In this embodiment, a buffer memory structure is organized to include at least one buffer memory pair for each of the raw image data files. The memory structure also has at least one resultant image buffer memory for storing all or part of the data from the final bitmap image to be transferred to the recording medium. The resultant image buffer memory can be organized to include at least one buffer memory pair. Alternatively, it can be organized as one large memory. In any event, all memory is organized to ensure image data are always available for the efficient operation of the imaging apparatus.

During operation, the portion or portions of the data from each raw image file that will ultimately appear in the final image are identified; these portions are herein referred to as "pertinent segments". Image data corresponding to the pertinent segments is buffered into the buffer memory pair dedicated to that file. Consequently, only the pertinent segments are copied from the dedicated buffer memory pairs into the resultant image buffer memory. Successive copying from each raw image file into the dedicated buffer memory pairs and into the resultant image buffer memory results in a complete representation of the final image on the recording medium.

An advantage of copying data from the raw image data files into separate and dedicated buffer memory pairs is evident with respect to data extraction speed. Typically, the raw image data files reside on data storage devices, such as mass storage media. Associated with mass storage media are data seek and read times. These times affect transactions with the mass storage media and contribute to an "overhead" that slows access to the data. During the compilation of the final image, it is necessary to retrieve data from several files—often with multiple accesses to the same file or files—as the

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pertinent segments are accessed and copied into the resultant image buffer. Consequently, the total overhead for compiling the entire, final image (e.g., the overhead per mass storage transaction multiplied by the number of transactions) can be large. This degrades system throughput and efficiency. Because the buffer memory pairs do not

5 have the overhead of mass storage media, data seek and read times for the former are greatly reduced. Thus, by first reading pertinent segments from the raw image data files into the buffer memory pairs (involving only one or a few mass storage transactions) and extracting the data for individual devices from the buffer memory pairs rather than from the mass storage media, the number of mass storage accesses is substantially decreased,

10 and overall throughput and efficiency are correspondingly increased.

In some instances, pertinent segments from two or more raw image data files can “overlap” in the final image. This can occur, for example, when overlaying titles or other characters onto a photograph: the title image could be one pertinent segment and the photographic image another pertinent segment. When image overlap occurs, it must

15 be determined which pertinent segment or segments will predominate over the others. Each pertinent segment that predominates is said to “occlude” the other pertinent segment or segments that it overlies. To manage such an event, an embodiment of the invention first determines that an overlap exists and then ascertains which pertinent segment predominates. Then, the data from the predominating pertinent segment (but

20 not the corresponding data from the occluded segment or segments) is copied from its buffer memory pair into the resultant image buffer memory.

In another embodiment, the invention uses an “opaque ink” model to determine the predominating pertinent segment. In this embodiment, all data from the buffer memory pairs representing pertinent segments is successively copied, segment by

25 segment, into the resultant image buffer memory. Image overlap is handled by allowing the later copied data to overwrite the earlier copied data; in other words, the opaque ink model operates temporally, with each successively copied image segment predominating over its predecessor. As a result, the data last copied to the resultant image buffer

memory represents the predominating pertinent segment that is ultimately imaged onto the recording medium.

One advantage of controlling image overlap by using predominating pertinent segments is the ability to include different printing jobs on a single output medium, such as a lithographic plate. For example, a system according to the invention may apply onto  
5 a single plate, without overlap, the images from two unrelated printing jobs, each of which requires the same stock. This allows both printing jobs to be completed at once, thereby improving operational efficiency and providing cost savings.

In another embodiment, the invention builds on the approach to compiling a  
10 final image described above. In this embodiment, at least two imaging devices and a recording medium are provided. The imaging devices can be, for example, lasers as described in U.S. Patent No. 5,351,617, assigned to the assignee of the present invention, and incorporated herein by reference. Further, the recording medium can be, by way of example, lithographic plates as described in U.S. Patent No. 5,339,737, Reissue No.  
15 35,512, and U.S. Patent No. 5,783,364, all assigned to the assignee of the present invention, and also incorporated herein by reference. The imaging devices and recording medium are placed in relative motion. During this motion, the imaging devices are activated in accordance with the data in the resultant image buffer memory. (As described above, the data in the resultant image buffer memory is a compilation of the  
20 pertinent segments and, as required, the predominating pertinent segments.) Consequently, the recording medium, after exposure to the imaging devices, has applied to it a representation of the data in the resultant image buffer.

Typically associated with each imaging device is an "imaging zone." This zone is the region on the recording medium that is scanned by a particular imaging device. In  
25 one example, the imaging devices take the form of a linear array and the recording medium is rotated on a drum or cylinder. The array of devices extends axially along the cylinder, so that rotation of the cylinder causes each device to scan a circumferential line

along the recording medium. After each complete rotation the array is indexed axially, so that the devices scan adjacent lines. This process of scanning and axial advancement continues until the entire image region of the recording medium has been fully scanned. (The process of scanning and axial advancement may also occur concurrently in a helical scan implementation of each imaging device, whereby the imaging devices are in constant motion across the recording medium.) At this point each device has scanned an imaging zone whose axial extent is equal to the spacing between adjacent imaging devices (and also represents the total distance that the array as a whole been indexed).

It is not uncommon for one dimension (e.g., the "width") of a pertinent segment to span several imaging zones. When this occurs, one embodiment of the invention determines, after defining the imaging zone for each imaging device, which imaging zones are spanned by the pertinent segments. This embodiment provides a pair of memory buffers for each such zone (whether spanned in whole or in part). Thus, instead of having one buffer memory pair for each raw image data file, this embodiment provides one buffer memory pair for each imaging device needed by each raw image data file. Data from each raw image file is then buffered into the buffer memory pairs dedicated to the required imaging devices for that file. This method of providing additional buffer memory pairs further improves raw image data throughput.

In one version of this embodiment, the invention includes an imaging apparatus having two or more imaging devices, a support for a recording medium, and a device to provide relative motion between the imaging devices and the support. This embodiment also includes a buffer memory structure having at least one buffer memory pair, a resultant image buffer, a control unit, and a drive unit. The control unit communicates with the buffer memory structure and the resultant image buffer, copying selected portions of data in the former into the latter. Note that these selected portions can be pertinent segments or, as required, predominating pertinent segments (both defined above) that the control unit had identified. The drive unit communicates with the control unit, the resultant image buffer, and the imaging devices. A purpose of the drive unit is to



activate, during scanning, the proper imaging devices in accordance with the data in the resultant image buffer. The result is application of an image onto the recording medium corresponding to the data in the resultant image buffer. In a further embodiment, the control unit, the drive unit, or both, may be a digital computer.

5           In another embodiment, the invention optimizes an image through adjustment of the size and resolution of the image. In this embodiment, a raw position signal is generated that indicates the position of the imaging devices with respect to the recording medium when they are in relative motion. Resolution enhancement and image size parameters are defined and multiply the raw position signal to generate a higher-  
10 frequency “subpixel clock”. An optimized position signal is generated by dividing the subpixel clock by at least one pixel prescaler, which, as described below, helps determine the size of the pixels. During the relative motion, the imaging devices are activated in accordance with image data at positions dictated by the optimized position signal rather than by the raw position signal. A result is that an optimized representation of the image  
15 data is applied onto the recording medium.

          In a version of this embodiment, the invention provides image optimization apparatus having two or more imaging devices, a support for a recording medium, and a device to provide relative motion between the imaging devices and the support. This embodiment also includes a sensing system that determines the position of the imaging  
20 devices relative to the recording medium. Typically, this sensing system has a position encoder communicating with a phase locked loop. The phase locked loop responds to the signal produced by the position encoder, a resolution enhancement parameter, and image size parameter. Further, the phase locked loop generates a second signal, the frequency of which is determined by the resolution enhancement and image size  
25 parameters. In general, the second signal (the subpixel clock) reflects the multiplication of the encoder signal by the resolution enhancement and image size parameters. Because the frequency of subpixel clock is higher than the encoder signal frequency, this clock provides submicron resolution of pixel position on the recording medium.

The center-to-center distance between adjacent image pixels is fixed and equal to a specific number of subpixel clock pulses, as determined by the image resolution. The frequency of the subpixel clock is reduced by dividing it by at least one pixel prescaler. This allows the starting point of each pixel to be adjusted relative to the center point of that pixel. Essentially, this affects the actual size of an image data element or pixel output onto the recording medium.

Manufacturing or assembly tolerances may result in variations in orientation between the imaging devices. To compensate, an offset register responsive to the subpixel clock is provided for each imaging device to adjust the starting point of the latter. Each pixel prescaler (typically one for each imaging device) is associated with, and responsive to, the corresponding offset register. These registers communicate with their associated pixel prescalers and determine, for each column of pixels, the placement of the first pixel on the recording medium. In the case where the imaging apparatus is a drum recorder, the offset values are typically adjusted on every revolution of the recording medium to correct for baseline variations.

Also included in this version are a control unit, in communication with and responsive to the sensing system and image data, as well as at least one drive unit. The drive unit is in communication with the control unit and the imaging devices. The drive unit responds to the at least one pixel prescaler and its associated offset register and selectively activates the imaging devices during, and at specific locations of, the relative motion, in accordance with image data and the optimized position signal. The drive unit determines the shape and duration of the signal that activates each imaging device, but it cannot initiate the firing of that imaging device until enabled by the pixel prescaler. Consequently, the drive unit, in combination with the pixel prescaler, determines the overall pixel size. Indeed, it is possible for the drive unit to continue firing an imaging device as it crosses a boundary between pixel adjacent pixel regions.

Note that the position encoder may be an angular position encoder. One or more of the control unit, the drive unit, and the sensing system may be a digital computer.

Another embodiment of the invention includes both the buffering and optimization methods discussed above. Specifically, in this embodiment, at least two  
5 imaging devices and a recording medium are provided and placed in relative motion. Also provided is a buffer memory structure that has at least one buffer memory pair for each raw image data file. The memory structure also has a resultant image buffer memory. During operation, the pertinent segments or, as required, the predominating  
10 pertinent segments, of the data are identified. Corresponding image data from each raw image file is buffered into a dedicated buffer memory pair. Pertinent (or predominating pertinent) segments of data are copied from the dedicated buffer memory pairs into the resultant image buffer memory.

Also in this embodiment, a raw position signal is generated that indicates the position of the imaging devices with respect to the recording medium when they are in  
15 relative motion. Defined resolution enhancement and image size parameters multiply the raw position signal to generate the subpixel clock. An optimized position signal is generated by dividing the subpixel clock by at least one pixel prescaler, in cooperation with associated offset registers. During the relative motion, the imaging devices are  
20 activated in accordance with data in the resultant image buffer and the optimized position signal. A result is that an optimized representation of data in the resultant image buffer is applied onto the recording medium.

In a version of this embodiment, the invention provides image processing apparatus having two or more imaging devices, a support for a recording medium, and a device to provide relative motion between the imaging devices and the support. This  
25 embodiment also includes a buffer memory structure having at least one buffer memory pair, a resultant image buffer, a control unit, a drive unit, and a sensing system. The control unit communicates with the sensing system, the buffer memory structure, and the

resultant image buffer. The control unit copies selected portions of data in the buffer memory structure into the resultant image buffer. Note that these selected portions can be pertinent segments or, as required, predominating pertinent segments. The sensing system determines the position of the imaging devices relative to the recording medium.

- 5 As stated above, this sensing system typically has a position encoder communicating with a phase locked loop. The phase locked loop responds to the signal produced by the position encoder, a resolution enhancement parameter, and image size parameter. Further, the phase locked loop generates a second signal the frequency of which is determined by the resolution enhancement and image size parameters. In general, the
- 10 second signal reflects the multiplication of the encoder signal by the resolution enhancement and image size parameters and division by at least one pixel prescaler.

- The drive unit, also in communication with the control unit, the resultant image buffer and the imaging devices, responds to the at least one pixel prescaler and its associated offset register. The drive unit controls the shape and duration of the signal
- 15 that activates the imaging devices, but will not activate the latter until enabled by the at least one pixel prescaler. Activation occurs during, and at specific locations of, the relative motion, in accordance with data in the resultant image buffer. This applies onto the recording medium an optimized representation of the image.

- In any of the embodiments described above, one or more of the control unit,
- 20 the drive unit, and the sensing system may be a digital computer. Consequently, one embodiment of the invention includes an article of manufacture that includes computer readable code for compiling image data and applying the corresponding image. The code includes portions for reading a raw image data file, buffering the contents of this file, identifying a pertinent segment from this file, copying the pertinent segment, and
- 25 activating imaging devices to apply the corresponding image. In another embodiment, a program storage medium tangibly embodies a program of instructions executable by a computer to perform the method steps for the aforementioned compilation and application.

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The image optimization described above may also be performed using a digital computer. In this case, an article of manufacture includes computer readable code for the optimized registration of image data. The code includes portions for generating a raw position signal, defining resolution enhancement and image size parameters, defining at  
5 least one pixel prescaler and an associated offset register, generating an optimized position signal, and activating imaging devices in accordance with the optimized position signal to register the corresponding image. In a further embodiment, a program storage medium tangibly embodies a program of instructions executable by a computer to perform the method steps for the aforementioned image optimization.

10 Other aspects and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating the principles of the invention by way of example.

#### Brief Description of the Drawings

The foregoing and other objects, features, and advantages of the present  
15 invention, as well as the invention itself, will be more fully understood from the following description of various embodiments, when read together with the accompanying drawings, in which:

Figure 1 is a block diagram of an image processing apparatus in accordance with an embodiment of the present invention;

20 Figure 2 is a schematic view of image zone buffers in accordance with an embodiment of the present invention; and

Figure 3 is a block diagram of a phase locked loop clocking scheme in accordance with an embodiment of the present invention.

### Detailed Description

As shown in the drawings for the purposes of illustration, the invention may be embodied in an image processing system. A system according to the invention increases operational efficiency and reduces or eliminates image registration errors.

5           An image processing apparatus according to the invention includes an improved buffer memory structure and, for dynamic image adjustment, a phase locked loop. The invention avoids the problems of degraded efficiency and image misalignment discussed above.

10           In the following detailed description and the drawings, like elements are identified with like reference numerals.

          Figure 1 shows a block diagram of an embodiment of an image processing apparatus 100. A typical printing press employs one or more imaging stations, each having a dedicated image processing apparatus 100. The image processing apparatus 100 includes a buffer memory structure 104, a resultant image buffer 108, and a drive unit 110, all in electrical communication with a control unit 102. The buffer memory structure 104 includes one or more buffer memory pairs 106. Although Figure 1 shows only three buffer memory pairs 106, this is for clarity only. Any number of buffer pairs 106 is within the scope of the present invention. In one embodiment, one buffer memory pair 106 is provided for each raw image data file that is a component of the final image.

20           In a further embodiment, one buffer memory pair 106 is provided for each imaging device 112 needed by each raw image data file. This is shown in Figure 2, which details an image zone buffer structure 200. Each zone corresponds to one imaging device 112. For clarity, only eight zones are shown (zone 0 (202) through zone 7 (216)) in Figure 2. Nevertheless, any number of zones is within the scope of the present invention.

25           In brief overview, Figure 2 shows two raw image data files with dimensional extents (e.g., "width") that span several imaging zones. File "Alpha" (218) spans zone 1

(204) through zone 3 (208). File “Beta” (220) spans zone 2 (206) through zone 7 (216). In this example, three buffer memory pairs 106 are provided for file “Alpha” (218): one pair for each of the three zones file “Alpha” (218) spans. Likewise, six buffer memory pairs 106 are provided for file “Beta” (220): one pair for each of the six zones file “Beta” (220) spans. In this embodiment, one buffer pair 106 is provided for each zone spanned, in whole or part, by each raw image data file that is a component of the final image.

During operation, the contents of raw image data files are read into the buffer memory pairs 106. Depending on the total amount of memory available, part or all of each raw image data file may be read into the buffer memory pairs 106. If only part of a raw image data file is read into a buffer memory pair 106, it is preferable that the part be the portion within the zone associated with that buffer memory pair 106. Nevertheless, acquiring data from the entirety of each raw image data file into the buffer memory pairs 106 can be accomplished efficiently based on a single mass storage retrieval transaction, thereby reducing data access overhead.

15 Pertinent segments from each raw image data file are identified and copied from their locations in each data file into the buffer memory pairs 106 for further copying into the resultant image buffer 108. Alternatively, all or part of each raw image data file, including both pertinent and “non-pertinent” segments, may be copied into the buffer memory pairs 106. In this case, only the pertinent segments are extracted from the buffer  
20 memory pairs 106 and copied into the resultant image buffer 108.

There may be cases where there is an overlap of pertinent segments. An example of this is shown in Figure 2 where file "Alpha" (218) and file "Beta" (220) overlap in zone 2 (206) and zone 3 (208). When there is an overlap, a predominating pertinent segment is identified. In this example, only one file, "Beta" (220), predominates in zone 2 (206) and zone 3 (208). (It is not necessary that the same file predominate in each zone.) The data representing the predominating pertinent segment, not the occluded segment or segments, is then copied into the resultant image buffer 108.

In one embodiment, the predominating pertinent segment is defined in accordance with an opaque ink model. In this embodiment, all data representing pertinent segments stored in the buffer memory pairs 106 is copied into the resultant image buffer 108. Image overlap is handled by allowing the later copied data to overwrite the earlier copied data. The data last copied to the resultant image buffer memory 108 therefore represents the predominating pertinent segment that is ultimately imaged onto a recording medium 114.

Also shown in Figure 1 is a device to provide relative motion 116, e.g., a motor. Device 116 provides relative motion between the imaging devices 112 and a support for a recording medium 118. Because the recording medium 114 is attached to the support 118, the recording medium 114 is also in relative motion with the imaging devices 112. Although Figure 1 shows the support 118 to be in the form of a drum and the recording medium 114 to be cylindrical in shape, other configurations are within the scope of the present invention. For example, the support 118 could be a flatbed-like structure and the recording medium 114 a planar surface. If desired, support 118 can be straightforwardly incorporated into the design of a conventional lithographic press, and serve as the plate cylinder of the press. Thus, the device 116 is the same motor that is used to rotate the print cylinder during printing. Alternatively, support 118 may reside on a stand-alone platesetting or proofing apparatus. In any configuration, the support 118 and recording medium 114 are shaped to fit closely.

The drive unit 110 is in electrical communication with the resultant image buffer 108 and the imaging devices 112. Again, for the purpose of clarity, only eight imaging devices 112 are shown in Figure 1; but any number of imaging devices 112 is within the scope of the present invention. During operation, while the relative motion is underway, the drive unit 110 activates the imaging devices 112 in accordance with the data in the resultant image buffer 108. This applies to the recording medium 114 an “imagewise” representation of the data in the resultant image buffer 108.



Also shown in Figure 1 is a sensing system 120 that is in electrical communication with the control unit 102. The sensing system 120 transmits to the control unit 102 the position of the support 118 (and, hence, the recording medium 114) relative to the imaging devices 112. The sensing system 120 includes a position encoder 122 and a phase locked loop 124. The position encoder 122 discerns the relative position between the recording medium 114 the imaging devices 112 during the relative motion between the two and generates an output signal that represents that position. This is referred to as a "raw position signal." In the case where the support 118 is in the form of a drum, rotating the recording medium 114 past the imaging devices 112, the position encoder 122 can be an angular encoder. The angular encoder would provide an output signal representing the angular position of the support 118 relative to the imaging devices 112.

Figure 3 shows a phase locked loop clocking scheme 300. The output signal of the position encoder 122 is supplied to a phase comparator 302 within the phase locked loop 124. The phase locked loop 124 includes a low pass filter-amplifier 304 and a voltage controlled oscillator 306. As is well known, a general purpose of any phase locked loop is to produce an output signal that is in phase with an input signal. As the phase of the input signal varies, a phase locked loop alters its output signal, causing the phase of the output signal to match that of the input signal. This is typically done by feeding back the output of the voltage controlled oscillator to an input of the phase comparator. In this embodiment, the voltage controlled oscillator output signal 312 that is fed back to the phase comparator 302 is first divided by an image size parameter 308 and a resolution enhancement parameter 310. An effect of this two-stage division is to change the frequency of the voltage controlled oscillator output signal 312. This changed frequency is related to the frequency of the output signal of the position encoder 122 multiplied by the image size parameter 308 and the resolution enhancement parameter 310. Furthermore, the voltage controlled oscillator output signal 312 remains in phase with the output signal of the position encoder 122.



At least one offset register 320 that is responsive to the subpixel clock is used to compensate for variation in “starting line references” between the imaging devices 112. This occurs when one imaging device has a different orientation compared to another, typically due to manufacturing or assembly tolerances. Consequently, the discharge of a misoriented imaging device will have a trajectory that differs from other imaging devices. This results in the discharges not reaching dimensionally consistent dot locations on the recording medium, thereby distorting the image.

To compensate for differences in starting line references, one embodiment includes unique offset register 320 for each of the imaging devices 112. In this configuration, each imaging device 112 has a dedicated pixel prescaler 316 that is associated with a unique offset register 320. The offset register 320 communicates with its associated pixel prescaler 316 to enable the drive unit 110. Accordingly, the pixel prescaler 316 and drive unit 110 together determine the size of the dots actually applied. Proper choice of a value for the offset register 320 for each imaging device will compensate for variations in orientation. Furthermore, the pixel prescaler 316 operates on the voltage controlled oscillator output signal 312 after the effects of the image size parameter 308 and the resolution enhancement parameter 310. This distributes the effects of these parameters uniformly across the entire image.

Adjusting the frequency of the raw position signal by changing the values of the image size parameter 308 and the resolution enhancement parameter 310 creates a subpixel clock. An optimized position signal is generated by dividing the subpixel clock by the at least one pixel prescaler 316. These parameter and prescaler values, which may be whole or fractional numerical quantities, accomplish this adjustment by, in essence, frequency modulating the raw position signal. A user may select values for these parameters by employing, for example, registers or counters, and communicate these values using a control interface 318. Despite the discrete nature of the parameter values, the frequency modulation results in spreading their effect smoothly over the analog voltage controlled oscillator output signal 312. This incorporates the image size and

enhancement adjustments smoothly and uniformly throughout image, with a result that is pleasing to the eye.

A further embodiment of the invention includes the additional feature of a digital computer performing the role or roles of one or more of the control unit 102, the drive unit 110, or the sensing system 120. Consequently, many of the actions described above, such as the buffering and image optimization, could be implemented in computer software, rather than in dedicated hardware. The reading of raw image data files, identification of image overlaps, copying of image data between buffers, and activating the imaging devices 112 could also be performed in software. Note that because Figure 1 is a block diagram, the enumerated items are shown as individual elements. In actual implementations of the invention, however, they may be inseparable components of other electronic devices such as a digital computer.

From the foregoing, it will be appreciated that the image processing system provided by the invention affords a simple and effective way to ensure efficient system operation while preserving the proper image size and alignment. The problems of low system throughput, compounded by slow data access times, are largely eliminated.

The image processing system described above facilitates the dynamic control of image size and alignment. Consequently, unacceptable image registration errors are reduced or eliminated.

One skilled in the art will realize the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The foregoing embodiments are therefore to be considered in all respects illustrative rather than limiting of the invention described herein. Scope of the invention is thus indicated by the appended claims, rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

## Claims

What is claimed is:

1. A method of compiling a resultant image, the method comprising the steps of:
  - providing a plurality of raw image data files;
  - providing a buffer memory structure comprising at least one buffer memory pair for each raw image data file;
  - identifying at least one pertinent segment from each of the raw image data files, the at least one pertinent segment being part of the resultant image;
  - buffering image data corresponding to the at least one pertinent segment from each raw image data file into the at least one buffer memory pair associated with the raw image data file; and
  - copying the at least one pertinent segment from the associated at least one buffer memory pair into a resultant image buffer.
2. The method of claim 1, wherein the step of identifying the at least one pertinent segment further comprises the steps of:
  - ascertaining the existence of at least one overlap of a plurality of pertinent segments in the resultant image;
  - determining for each overlap a predominating pertinent segment having precedence in the resultant image; and
  - classifying the predominating pertinent segment as the at least one pertinent segment.





1           9. An imaging apparatus comprising:  
 2           a plurality of imaging devices;  
 3           a support for a recording medium;  
 4           a device to provide relative motion between the imaging devices and the  
 5           support;  
 6           a buffer memory structure further comprising at least one buffer memory  
 7           pair;  
 8           a resultant image buffer;  
 9           a control unit in electrical communication with the buffer memory  
 10          structure and the resultant image buffer, the control unit operating so as to  
 11          copy selected portions of data in the buffer memory structure into the  
 12          resultant image buffer; and  
 13          a drive unit in electrical communication with the control unit, the resultant  
 14          image buffer and the imaging devices, the drive unit activating the imaging  
 15          devices during the relative motion and in accordance with data in the  
 16          resultant image buffer, thereby applying to the recording medium a  
 17          representation of data in the resultant image buffer.

1           10. The imaging apparatus of claim 9, wherein at least one of the control unit  
 2           and the drive unit further comprises a digital computer.

1           11. A method of image optimization, the method comprising the steps of:  
 2           providing image data;  
 3           providing a plurality of imaging devices;



4 providing a recording medium;  
5 causing relative motion between the imaging devices and the recording  
6 medium;  
7 generating a raw position signal indicative of the position of the imaging  
8 devices relative to the recording medium;  
9 defining a resolution enhancement parameter;  
10 defining an image size parameter;  
11 defining at least one offset register;  
12 defining at least one pixel prescaler responsive to the at least one offset  
13 register;  
14 generating an optimized position signal by multiplying the raw position  
15 signal by the resolution enhancement and the image size parameters and  
16 dividing by the at least one pixel prescaler; and  
17 activating the imaging devices during the relative motion in accordance  
18 with the optimized position signal and the image data, thereby applying to  
19 the recording medium an optimized representation of the image data.

1 12. An image optimization apparatus comprising:  
2 a plurality of imaging devices;  
3 a support for a recording medium;  
4 a device to provide relative motion between the imaging devices and the  
5 support;

15 a drive unit in electrical communication with the control unit and the  
16 imaging devices, the drive unit responding to at least one pixel prescaler  
17 and selectively activating the imaging devices during the relative motion at  
18 locations corresponding to the image data, thereby applying to the  
19 recording medium an optimized representation of the image data.

- 1 13. The image optimization apparatus of claim 12, wherein the position  
2 encoder further comprises an angular position encoder.
- 1 14. The image optimization apparatus of claim 12, wherein the second signal  
2 indicates successive imaging positions and reflects multiplication of the  
3 first signal by the resolution enhancement parameter, the second signal  
4 thereby providing an enhanced position resolution relative to the first  
5 signal.
- 1 15. The image optimization apparatus of claim 12, wherein the second signal  
2 indicates successive imaging positions and reflects multiplication of the  
3 first signal by the image size parameter, the second signal thereby scaling  
4 image size.

- 1 16. The image optimization apparatus of claim 12, wherein the second signal  
2 is further divided by the at least one pixel prescaler.
- 1 17. The image optimization apparatus of claim 12, wherein at least one of the  
2 control unit, the drive unit, and the sensing system further comprises a  
3 digital computer.
- 1 18. A method of image processing, the method comprising the steps of:  
2 providing a plurality of raw image data files;  
3 providing a plurality of imaging devices;  
4 providing a recording medium;  
5 providing a buffer memory structure comprising at least one buffer  
6 memory pair for each raw image data file;  
7 causing relative motion between the imaging devices and the recording  
8 medium;  
9 identifying at least one pertinent segment from each of the raw image data  
10 files, the at least one pertinent segment being part of the resultant image;  
11 buffering image data corresponding to the at least one pertinent segment  
12 from each raw image data file into the at least one buffer memory pair  
13 associated with the raw image data file;  
14 copying the at least one pertinent segment from the associated at least one  
15 buffer memory pair into a resultant image buffer;  
16 generating a raw position signal indicative of the position of the imaging  
17 devices relative to the recording medium;

18 defining a resolution enhancement parameter;  
19 defining an image size parameter;  
20 defining at least one offset register;  
21 defining at least one pixel prescaler responsive to the offset register;  
22 generating an optimized position signal by multiplying the raw position  
23 signal by the resolution enhancement and the image size parameters and  
24 dividing by the at least one pixel prescaler; and  
25 activating the imaging devices during the relative motion in accordance  
26 with data in the resultant image buffer and the optimized position signal,  
27 thereby applying to the recording medium an optimized representation of  
28 the data in the resultant image buffer.

1 19. The method of claim 18, wherein the step of providing a buffer memory  
2 structure further comprises the steps of:

3 defining an imaging zone for each imaging device;  
4 determining which imaging zones are required to image each raw image  
5 data file; and  
6 providing, for each raw image data file, a buffer memory pair for each  
7 required imaging zone.

1 20. The method of claim 19, wherein the buffering step further comprises  
2 buffering image data corresponding to the at least one pertinent segment  
3 from each raw image data file into the buffer memory pair provided for  
4 each required imaging zone.

classifying the predominating pertinent segment as the at least one pertinent segment.

a sensing system to determine the position of the imaging devices relative to the recording medium, the sensing system further comprising a position encoder and a phase locked loop, the position encoder generating a first

12 signal indicative of the position, the phase locked loop responding to (i)  
13 the first signal, (ii) a resolution enhancement parameter and (iii) an image  
14 size parameter so as to generate a second signal, the second signal having  
15 a frequency determined by the resolution enhancement and image size  
16 parameters;

17 a control unit responsive to the sensing system and in electrical  
18 communication with the buffer memory structure and the resultant image  
19 buffer, the control unit operating so as to copy selected portions of data in  
20 the buffer memory structure into the resultant image buffer; and

21 a drive unit in electrical communication with the control unit, the resultant  
22 image buffer and the imaging devices, the drive unit responding to at least  
23 one pixel prescaler and operating so as to activate the imaging devices  
24 during, and at specific locations of, the relative motion, in accordance with  
25 data in the resultant image buffer, thereby applying to the recording  
26 medium an optimized representation of data in the resultant image buffer.

1 24. The image processing apparatus of claim 23, wherein the position encoder  
2 further comprises an angular position encoder.

1 25. The image processing apparatus of claim 23, wherein the second signal  
2 indicates successive imaging positions and reflects multiplication of the  
3 first signal by the resolution enhancement parameter, the second signal  
4 thereby providing an enhanced position resolution relative to the first  
5 signal.

1 26. The image processing apparatus of claim 23, wherein the second signal  
2 indicates successive imaging positions and reflects multiplication of the  
3 first signal by the image size parameter, the second signal thereby scaling  
4 image size.









11 generating an optimized position signal by multiplying the raw position  
12 signal by the resolution enhancement and the image size parameters and  
13 dividing by the at least one pixel prescaler; and  
  
14 activating a plurality of imaging devices in accordance with the optimized  
15 position signal and the image data, so as to achieve optimized application  
16 of the image corresponding to the image data.

## Method and Apparatus for Optimized Image Processing

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### Abstract of the Disclosure

5 An image processing system for digital printing for improving throughput and efficiency of the transfer of image data to imaging devices, such as lasers, while allowing for dynamic and continuous adjustment of image size and registration (i.e., alignment) on recording media. A buffer memory structure is configured to receive data from raw image files. Specific portions of data are copied from the raw image files into a buffer memory structure and, for compilation of the final image, into an image buffer. Image overlap is resolved by copying data into the image buffer according to a defined hierarchy. Using a phase locked loop, image size and registration are adjusted to optimize the appearance of the final image on the recording medium. The optimization is performed dynamically and continuously, thereby providing a uniform final image. Many aspects of the operation of the image processing system may be under the control of a digital computer.

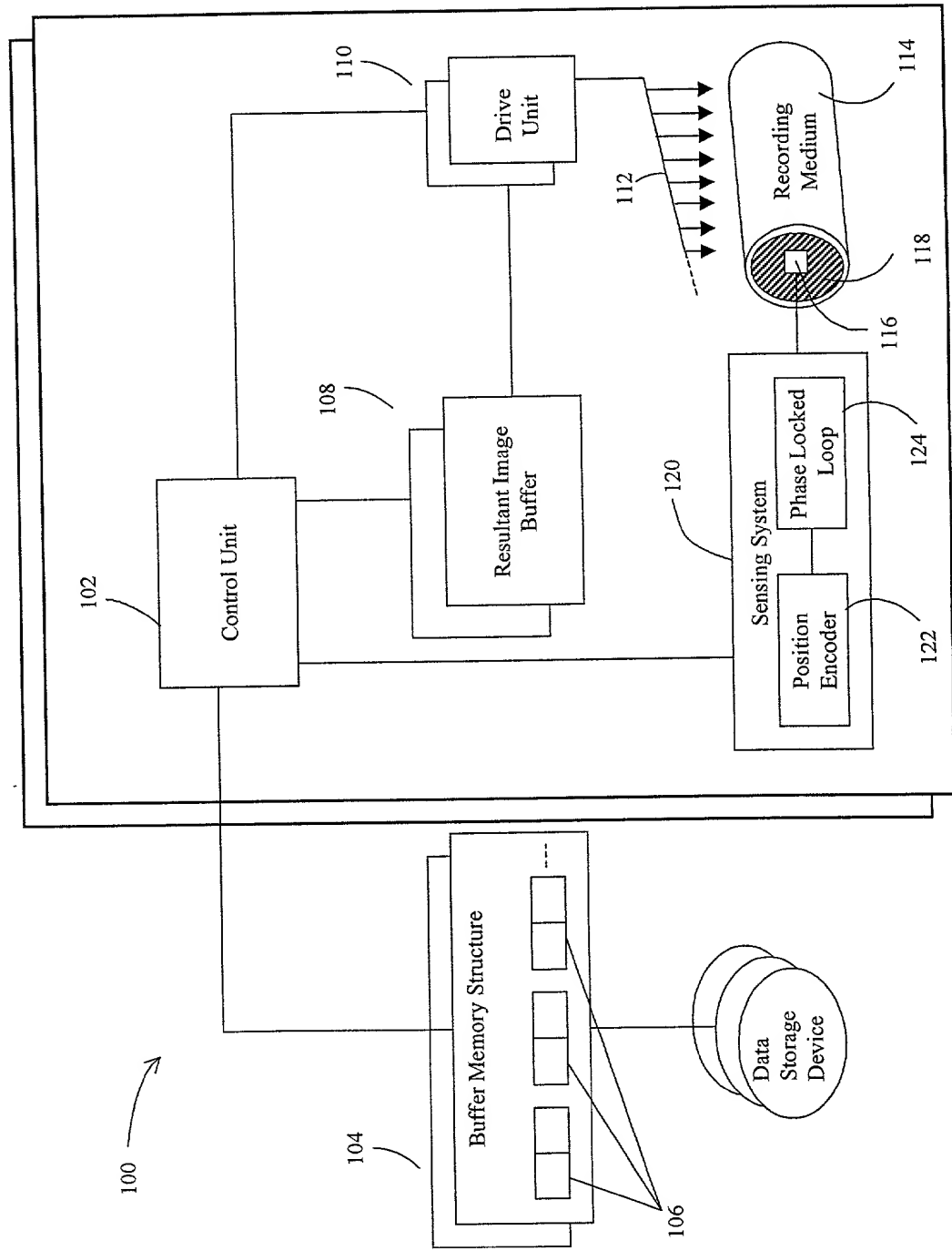
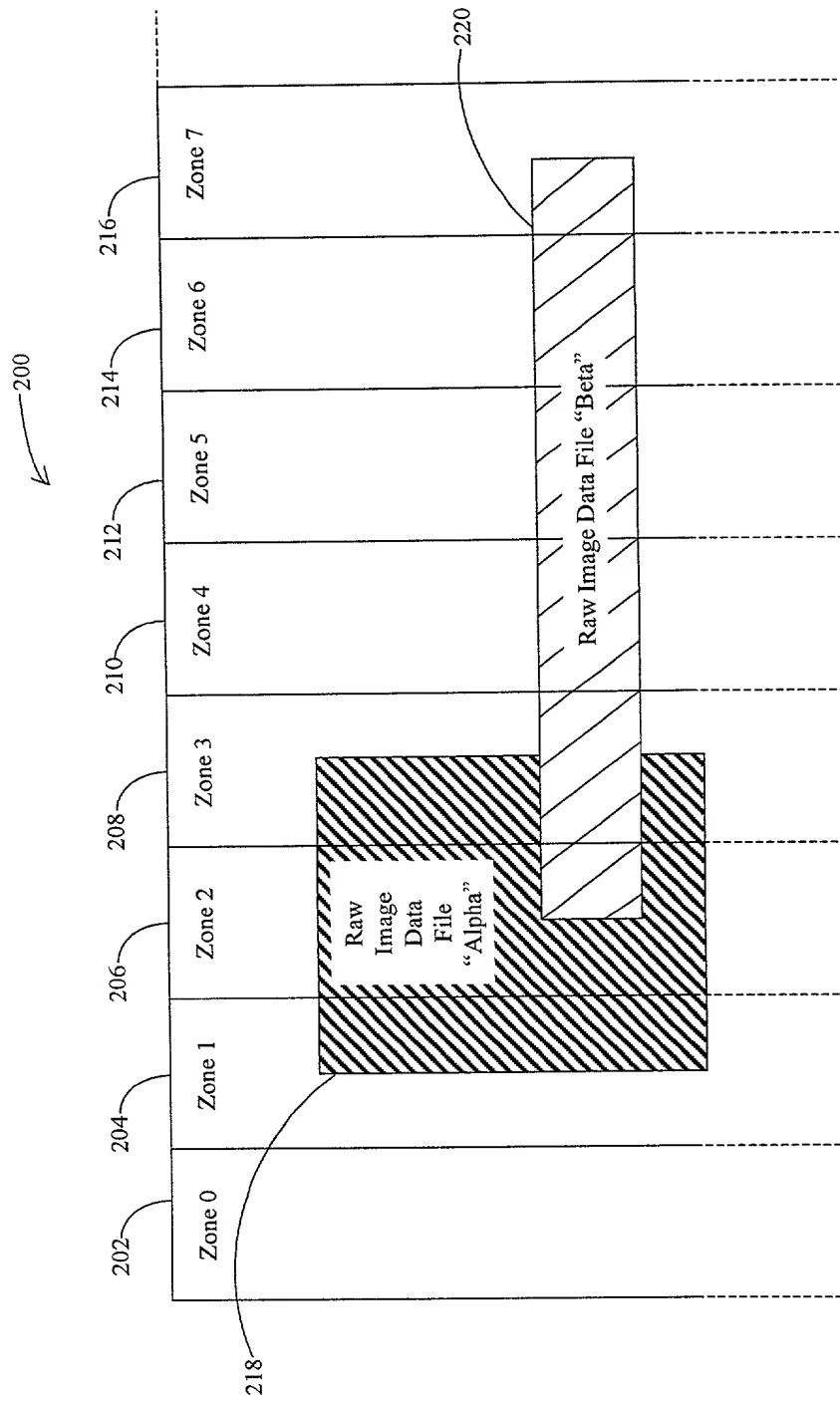


Figure 1



**Figure 2**

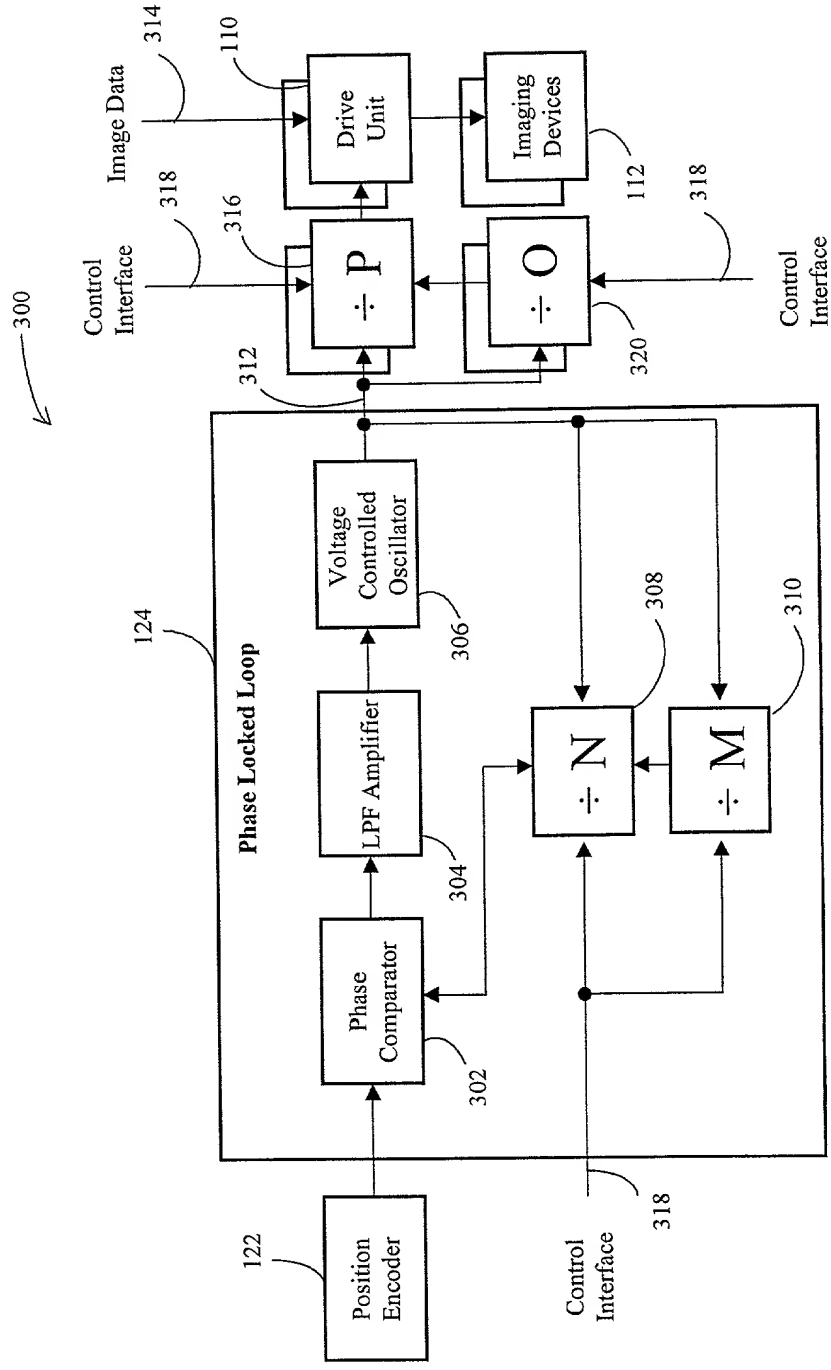


Figure 3

<b>DECLARATION AND POWER OF ATTORNEY FOR UTILITY OR DESIGN  PATENT APPLICATION</b>  <input checked="" type="checkbox"/> Declaration <input type="checkbox"/> Declaration Submitted with      Submitted after Initial Initial Filing      Filing (surcharge 37 CFR 1.16(e) required)	Attorney Docket No.	PTK-195 (465/2)
	First Named Inventor	CABANA
	<b>COMPLETE IF KNOWN</b>	
	Application Serial Number	To Be Assigned
	Filing Date	Herewith
	Group Art Unit	To Be Assigned
Examiner Name	To Be Assigned	

**As a below named inventor, I hereby declare that:**

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**METHOD AND APPRATUS FOR OPTIMIZED IMAGE PROCESSING**

*(Title of the Invention)*

the specification of which

☒ is attached hereto  
OR

☐ was filed on  as United States Application Serial Number or PCT International (MM/DD/YYYY)

Application Number  and was amended on (MM/DD/YYYY)  (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose to the Patent Office all information known by me to be material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
			<input type="checkbox"/>	YES <input type="checkbox"/>	NO <input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet attached hereto.

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Serial Number(s)	Filing Date (MM/DD/YYYY)	<input type="checkbox"/> Additional provisional application serial numbers are listed on a supplemental priority data sheet attached hereto.

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c), of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Serial Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

As a named inventor, I hereby appoint the following registered practitioners to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☐ Customer Number ☐ *Place Customer*

OR

☒ Registered practitioners names/registration numbers listed below

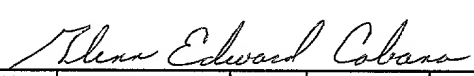

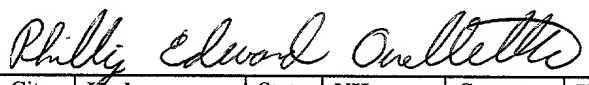
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Jennifer A. Camacho	43,526	Edmund R. Pitcher	27,829
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Kurt W. Lockwood	40,704		

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Given Name (first and middle [if any])				Family Name or Surname				
Glenn Edward				CABANA				
Inventor's Signature						Date		
						15-Nov		
						2000		
Residence	City	Derry	State	NH	Country	USA	Citizenship	USA
Post Office Address	3 James Street							
P.O. Address (line 2)	City	Derry	State	NH	ZIP	03038	Country	USA
<input type="checkbox"/> Additional inventors are being named on the _____ supplemental Additional Inventor(s) sheet(s) attached hereto.								
<b>Name of Additional Joint Inventor, if any:</b>		<input type="checkbox"/> A petition has been filed for this unsigned inventor						
Given Name (first and middle [if any])				Family Name or Surname				
Charles Francis				HUNT				
Inventor's Signature						Date		
						Nov 15		
						2000		
Residence	City	Hampstead	State	NH	Country	USA	Citizenship	USA
Post Office Address	6 Anne Drive							
P.O. Address (line 2)	City	Hampstead	State	NH	ZIP	03841	Country	USA
<b>Name of Additional Joint Inventor, if any:</b>		<input type="checkbox"/> A petition has been filed for this unsigned inventor						
Given Name (first and middle [if any])				Family Name or Surname				
Phillip Edward				OUELLETTE				
Inventor's Signature						Date		
						Nov 15		
						2000		
Residence	City	Hudson	State	NH	Country	USA	Citizenship	USA
Post Office Address	10 Sandalwood Road							
P.O. Address (line 2)	City	Hudson	State	NH	ZIP	03051	Country	USA

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Name of Additional Joint Inventor, if any:				<input type="checkbox"/> A petition has been filed for this unsigned inventor				
Given Name (first and middle [if any])				Family Name or Surname				
Dwayne Thomas				JEFFREY				
Inventor's Signature				Date				
				12/01/15		2:00		
Residence	City	Amherst	State	NH	Country	USA	Citizenship	USA
Post Office Address	5 Wildwood Lane							
P.O. Address (line 2)	City	Amherst	State	NH	ZIP	03031	Country	USA

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Variable	Mean	SD	Min	Max
Age	34.5	10.2	21	55
Gender	0.5	0.5	0	1
Marital status	0.6	0.5	0	1
Education	12.5	1.5	9	16
Income	1500	500	500	3000
Health status	0.8	0.2	0	1
Employment status	0.7	0.3	0	1
Family size	3.2	1.1	1	6
Home ownership	0.9	0.1	0	1
Vehicle ownership	0.6	0.5	0	1
Life satisfaction	4.5	1.2	1	7
Subjective health	5.2	1.5	1	7
Life expectancy	78.5	5.5	65	90
Quality of life	6.8	1.8	1	10
Healthcare utilization	2.1	0.8	0	4
Health insurance	0.9	0.1	0	1
Healthcare access	0.7	0.3	0	1
Healthcare cost	1200	400	500	2500
Healthcare quality	7.5	1.0	5	10
Healthcare satisfaction	6.2	1.5	3	10
Healthcare equity	7.8	1.2	5	10
Healthcare efficiency	7.0	1.0	5	10
Healthcare effectiveness	7.2	1.0	5	10
Healthcare safety	7.5	1.0	5	10
Healthcare accessibility	7.0	1.0	5	10
Healthcare affordability	6.5	1.0	5	10
Healthcare availability	7.0	1.0	5	10
Healthcare acceptability	7.0	1.0	5	10
Healthcare appropriateness	7.0	1.0	5	10
Healthcare timeliness	7.0	1.0	5	10
Healthcare responsiveness	7.0	1.0	5	10
Healthcare reliability	7.0	1.0	5	10
Healthcare predictability	7.0	1.0	5	10
Healthcare consistency	7.0	1.0	5	10
Healthcare transparency	7.0	1.0	5	10
Healthcare accountability	7.0	1.0	5	10
Healthcare integrity	7.0	1.0	5	10
Healthcare honesty	7.0	1.0	5	10
Healthcare openness	7.0	1.0	5	10
Healthcare communication	7.0	1.0	5	10
Healthcare information	7.0	1.0	5	10
Healthcare education	7.0	1.0	5	10
Healthcare training	7.0	1.0	5	10
Healthcare research	7.0	1.0	5	10
Healthcare innovation	7.0	1.0	5	10
Healthcare leadership	7.0	1.0	5	10
Healthcare vision	7.0	1.0	5	10
Healthcare mission	7.0	1.0	5	10
Healthcare values	7.0	1.0	5	10
Healthcare ethics	7.0	1.0	5	10
Healthcare law	7.0	1.0	5	10
Healthcare policy	7.0	1.0	5	10
Healthcare regulation	7.0	1.0	5	10
Healthcare standards	7.0	1.0	5	10
Healthcare guidelines	7.0	1.0	5	10
Healthcare protocols	7.0	1.0	5	10
Healthcare procedures	7.0	1.0	5	10
Healthcare practices	7.0	1.0	5	10
Healthcare techniques	7.0	1.0	5	10
Healthcare methods	7.0	1.0	5	10
Healthcare approaches	7.0	1.0	5	10
Healthcare strategies	7.0	1.0	5	10
Healthcare plans	7.0	1.0	5	10
Healthcare programs	7.0	1.0	5	10
Healthcare services	7.0	1.0	5	10
Healthcare products	7.0	1.0	5	10
Healthcare equipment	7.0	1.0	5	10
Healthcare facilities	7.0	1.0	5	10
Healthcare infrastructure	7.0	1.0	5	10
Healthcare systems	7.0	1.0	5	10
Healthcare networks	7.0	1.0	5	10
Healthcare organizations	7.0	1.0	5	10
Healthcare institutions	7.0	1.0	5	10
Healthcare providers	7.0	1.0	5	10
Healthcare professionals	7.0	1.0	5	10
Healthcare workers	7.0	1.0	5	10
Healthcare staff	7.0	1.0	5	10
Healthcare personnel	7.0	1.0	5	10
Healthcare teams	7.0	1.0	5	10
Healthcare groups	7.0	1.0	5	10
Healthcare communities	7.0	1.0	5	10
Healthcare populations	7.0	1.0	5	10
Healthcare societies	7.0	1.0		